Evaporation.—By certain methods in use at the experiment stations the amount of water in the soil at seeding time is determined. At stated intervals the soil is weighed to determine the loss through evaporation. The difference between the initial and final weight each month indicates the water lost by the soil through evaporation and transpiration of the plants. It is stated that, as a rule, rainfall higher than average in dry climates results in yields higher than average, while in humid climates rainfall less than average usually produces yields higher than average. (Studies on yields and weather in other parts of Canada additional to that undertaken in the Prairie Provinces will be carried out in order to contrast the relationship in climates different from that of the west.) This might be partly due to less evaporation in humid climates; the supply of soil moisture thereby being more constant than in dry areas like that of southwestern Saskatchewan and in fact other parts of the prairies where the soil moisture is so rapidly depleted, and where abundant rains are at all times a necessity. Our study of the problem has convinced us that the rainfall is of prime importance. Unfortunately, however, data of sufficient amount to cover a great many more areas in the grain-growing regions of the west are not yet available.

Encouraging results, up to the present time, have been obtained and have led to the belief that the possibilities of estimating the yield of the various crops, based on the study of weather conditions of past periods, are very good. It will be quite possible, in fact, to make a prediction as to the outcome of the crop early in the season (in addition to the many reports on condition, based on averages) directly by taking the number of inches of rain at stated periods ("weighting" by proper methods) and from the above results making a calculation, in yield per acre, of the crop. Of course, the nonmeteorological agencies mentioned will be given consideration. The study of this problem, up to this point, has been the endeavor to establish some relationship between yield and weather, so that the various factors, principally rainfall and temperature, might be given certain values or weights in order to make, if possible, some calculation of the probable yield as compared with the actual yields reported by other methods now already established by the provincial governments, the Dominion Bureau of Statistics, and other agencies interested in the outcome of the crop, such as the grain exchange, the different wheat pools, Sanford Evans Statistical Agency, and the farming community in general.

Conclusion.—The important points which have been brought out in this article are, first, that rainfall, at certain periods of the year, is perhaps more important than at other times, depending on the crop that is grown. Our study has been on the yield of spring wheat in the prairie Provinces of Canada. Here we have investigated the yields both at several points in the Province of Saskatchewan for a particular year, namely, 1925, and over a period of years, namely, 1914–28, in each of the Provinces. We have brought out the fact that, of the two weather factors studied, rainfall and temperature, the first is the most influential. The way in which rainfall comes has a great deal to do with its usefulness. Showers during the growing period help the crop for a short time, but for storing water in the soil, showers of one-half inch or more are necessary. Then, the distribution of rainfall is very important. If the rainfall is of a torrential character, the rain falling at the rate of an inch or more per hour, the loss through run-off is serious. The summer-fallow is quite important and is partly for the purpose of controlling weeds and for storing moisture. Secondly, we have evaporation, which in many cases exceeds the amount of rainfall, so that the amount of soil moisture is lessened. Then, there are several other factors which are at work to reduce the yields besides lack of rainfall, such as lateness of seeding, poor cultural methods, poor seed, the wrong type of soil for a certain crop—although in this case well-distributed rainfall on comparatively poor soil might produce a good crop, while less than the average rainfall would result in a poor crop or none at all, as we have witnessed this past year in the West. Insect injury, plant diseases, and soil drifting are partly dependent upon moisture conditions as well as on temperature. It has been the endeavor of the writer to link up all these factors together over a period of years. The experience of past seasons has assisted in making some kind of a prediction of the crop. The successful solution of estimating yields, however, requires the cooperation of not only a specialist in statistics but also in agriculture and weather forecasting. It is planned to make an extended field study of crops over a period of years, and it is confidently hoped that a method will be found of accurately determining the yield of crops early in the season.

TIME LIMITS OF THE DAY AS AFFECTING RECORDS OF MINIMUM TEMPERATURE

By E. S. NICHOLS

[Weather Bureau office, Harlingen, Tex., July 1934]

Different methods of obtaining temperature records, especially variations in the time at which observations are taken, cause differences in the beginning and the end of the "day" for which temperature extremes are recorded. Thus, at regular Weather Bureau stations the daily maximum and minimum temperatures are recorded for the calendar day, midnight to midnight, local standard time, the data being taken from the station thermograms when the extremes are not shown by actual thermometer readings; while the recommended, though not universal, time for the once-daily observations at cooperative climatological stations is "about sunset"; and the maximum and minimum temperatures then read are recorded as belonging to the current day (on which they usually occur). At certain other stations, especially certain classes operated in some special services, as well as at some cooperative climatological stations, thermometers are read and set once daily in the morning, in many cases at 7 a. m. local time, or even earlier; and the minimum temperature then read is recorded as that of the current date, while the maximum-thermometer reading is, in published reports, set back to the preceding date, on which it almost always occurs. The early-morning readings are, at some stations, supplemented by additional afternoon settings of the minimum thermometer. Experience in different sections of the United States has shown that such differences in the periods taken as the "day" (even though each contains 24 hours) cause differences in the temperature records obtained; and questions arise regarding the frequency, amount, and importance of such variations in the records.

PREVIOUS INVESTIGATIONS

Hann and Süring in their "Lehrbuch" object to the use of the maximum-minimum thermometer, because of the ease with which the instrument becomes out of order and because of sunshine effects on the maximum reading, but is silent as to results of variation in the time of setting,[1] as are other writers generally. However, Ward in his translation of Hann's Handbuch der Klimatologie refers to a study of time-of-observation effects on the maximum, minimum, and mean temperatures at the Royal Observatory, Greenwich, during the years 1886–89, by Ellis.[2] Apparently the time of observation is not generally considered as of great importance.

DATA USED IN PRESENT INVESTIGATION

In the present paper certain phases of the subject are considered through examination of the minimum temperatures that occurred during portions of three frost seasons (cold portions of the year) in the Rio Grande fruit-frost district of south Texas, where requisite thermograph records have been obtained for a number of field stations. Three of these stations have been selected for study: Harlingen and Mission in the lower Rio Grande Valley (the former station relatively near the coast of the Gulf of Mexico and the latter about 39 miles west of Harlingen, in the interior) and Dilley, located in the "winter garden" section southwest of San Antonio. Approximate latitudes, longitudes, and variations of local mean solar time from central standard time (the standard in local use) are as follows, for the three chosen stations:

Stations	Latitudes (north)	Longitudes (west)	Time differences
	° ′	° ′	
Harlingen	26 12	97 42	31 minutes slower.
Mission	26 13	98 20	33 minutes slower.
Dilley	28 41	99 11	37 minutes slower.

DESCRIPTION OF TABLES

Taking the minimum temperature (to whole degrees Fahrenheit) for each 24-hour period ended at 6 p. m. as the standard and using thermograms corrected for available readings of the maximum and minimum thermometers, differences in the daily minimum temperatures resulting from considering the day as ending at 7 a. m., 8 a. m., and midnight, central standard time, have been determined separately for each of the three stations chosen, for December, 1931, 1932, and 1933, and for January, February, and March, of 1932, 1933, and 1934. We might have taken any other time than 6 p. m. as the preliminary standard, but this time is chosen for reasons that will appear later, as well as because it is "about sunset", which is, as already stated, the preferred time for cooperative climatological station observations. The minimum temperatures we use for each date are, of course, those that would have been obtained by once-daily settings of the minimum thermometer at each time of day specified.

In tables 1, 2, and 3, herewith, have been entered for Harlingen, Mission, and Dilley, respectively, for each of the 12 months listed above and for each of the four sets of 3 months of the same name comprising the 12, the numbers of cases, the totals, and the greatest of positive and of negative departures of the daily minimum temperatures from the 6 p. m. standard determined as above. By this method any date on which the minimum temperatures for the 6 p. m. and any other type of day are the same is not counted in that connection, since the departure is 0. Also, the totals of the absolute values of all the positive and the negative departures together and the averages thereof have been entered for each period, station, and type of day, as well as the resultant algebraic sums and the average daily amounts of such resultants (sums divided by number of days in periods). The latter averages, therefore, give the amounts by which the respective monthly mean minimum temperatures are affected by the variations in the "day" used. Finally, at the bottom of each table are given, for each type of day, the total number of negative, the total number of positive, and the total number of all departures, together with the percentage frequencies of the grand totals; i. e., 100 times the grand totals (of frequencies) divided by 364 (the number of days in our 12-month period).

In the second portion of each table are entered, for each type of day, the number of times minimum temperatures of 40° or lower, 32°, 25°, and 20°, or lower occurred in each monthly or trimonthly period, while at the bottom of this portion are given the total number of times each low-temperature group occurred, together with the percentage changes (increases in all cases) from the number of times of occurrence during the 6 p. m.-ending days.

WHAT THE DATA SHOW

While frequencies of low temperatures at Dilley, as shown by the second parts of tables 1, 2, and 3, are considerably greater and the mean minimum temperatures there (as shown by published climatological reports) are several degrees lower than corresponding data for the other two stations we are using, the frequencies, averages, and extremes of departures and the relative (percentage) variations in frequencies of low temperatures for the three places do not differ greatly. Frequencies of departures of whichever sign for the 7 a. m.-ending days for the entire 12 months are nearly or quite 50 percent; that is, about *one-half* of the daily minima differ from those for the corresponding 6 p. m.-ending days. Departure frequencies decrease to slightly more than one-third of all cases when 8 a. m., instead of 7 a. m., minima are used; and to about one-fourth or one-fifth when we use midnight-to-midnight minima. Negative departures are several times as frequent as positives in the 7 a. m. data; and, while the relative excess of negatives decreases at 8 a. m. and still more when we take the midnight cases, negatives continue the more frequent during all these types of day.

Occasional cases of departures of nearly or quite 20°, and even more in a few cases, both positive and negative are scattered through our tables, least frequently in the midnight columns. Trimonthly averages of all departures during 7 a. m.-ending data are mostly about 5° or 6°; they are usually less for the other types, being about 4° for midnight. In general the negative departures make greater monthly totals than the positive, so that resultant departures and daily averages thereof are mostly negative; these averages mostly fall within the limits −1.5° and −2.5° for the 7 a. m. days (all averages being negative at this time); −0.8 to −1.5° for the 8

[1] Lehrbuch der Meteorologie, fourth edition, p. 95.
[2] Handbook of Climatology, by Julius Hann, translated by R. DeC. Ward, p. 8, refers to "On the Difference Produced in the Mean Temperature Derived from Daily Maxima and Minima as Dependent on the Time at which the Thermometers are Read", by W. Ellis, in Quart. Jour. Roy. Met. Soc., XVI, 1890, 213–218.

a. m. days, though 3 or 4 slight positive averages were found; and from −0.5° to −1.0° for midnight, all of these averages being negative though one is as small as −0.1°.

CAUSES OF DIFFERENCES

Even a cursory examination of the individual records shows that the most of the negative differences for 7 and 8 a. m. are due to the fact that the current temperatures (temperatures at which thermometers are set if observations be taken then) at those times are often lower than the temperature at any time during the ensuing night; that many of the negative departures for the midnight-ending days are due to the fall of temperature between 6 p. m. and midnight to points lower than the minima of the immediately preceding nights. On the other hand, many of the 7 and 8 a. m. positive departures are due to the fall of temperature during the remainder of the forenoon and the afternoon up to 6 p. m. to points lower than the minimum of the preceding night and early morning; and that some of the positive departures for midnight-ending days are due to the occurrence of nocturnal minima previous to midnight. (Numerous thermograms might be given to illustrate these conditions.) There remain fortuitous differences that are due mainly to the onset of, and recovery from, cold waves, and that are to a considerable extent independent of our time limits.

ADDITIONAL TIMES CONSIDERED

Because of the above-mentioned causes of negative departures when our "day" ends during the early morning hours, data similar to those of tables 1, 2, and 3 have been prepared for days ending at 9 and 10 a. m., noon, and 3 p. m., using the same thermograms as were used in preparing the Harlingen table 1. These new data appear in table 4, herewith. It appears from the preceding discussion that data for the other two stations previously used would not show essentially different results. Further decreases in the total numbers of positive and of negative differences are shown for progressively later hours, especially between 8 a. m. and 9 a. m., less between 9 and 10 a. m., and still less between 10 a. m. and noon. Noon and 3 p. m. frequencies do not differ greatly, and they are relatively low, being only 7 and 5 percent, respectively. Ten a. m. has only 10 percent. From 10 a. m. onward to 3 p. m., frequencies and totals of positive exceed those of negative differences; and resultant averages are, therefore, positive though amounting to only from one- to four-tenths of a degree. Extreme differences have decreased, positives seldom reaching 10° at noon or more than 5° at 3 p. m., while extreme minima have fallen to about 5° in the 10 a. m. columns to 1° or 2° in the noon, and to 1° or 0° in the 3 p. m. lists. Averages of all positive and negative differences hold up well until 10 a. m., when they are about 5°; a fall to about 4° occurs at noon, and a further drop to about 3° is found for 3 p. m.

IMPORTANCE OF DIFFERENCES

From the above we see that the use of different times for the termination of the "day" may considerably affect the record of minimum temperature, especially by producing numerous, and at times large, variations in the minima recorded for the same dates. Data for stations that use different time limits for the day are, therefore, not comparable. For instance: If minimum temperature data for Harlingen be obtained by using the late afternoon-ending day, those for Mission by use of the 7- or 8-a. m.-ending day, and those for Brownsville by using the midnight-to-midnight day, wide differences in the records are necessarily introduced, which may accentuate or cancel any real differences that exist among these stations, all of which are located in the lower Rio Grande Valley. While frequencies and amounts of differences would doubtless be different in other sections of the country, variations of similar nature may be expected there. It is true, of course, that daily positive and negative departures tend to cancel each other in resultant monthly sums and averages; but the daily values and frequencies are the more important biologically, for the mean temperature is not actually experienced.[3]

It is, therefore, very desirable that an at least approximately uniform time be adopted for the termination of the periods to be used in finding daily minimum (as well as maximum) temperatures at all stations. It remains to be seen which time is most desirable. If we examine a series of thermograms for any section of the United States we see that (excepting such unusual cases as those already referred to in connection with cold-waves, cases when daily amplitude of temperature is negligible, etc.) the curves showing the march of temperature are irregular periodic wavy lines, in general form similar to a sinusoid curve but having varying amplitudes and extremes of ordinates; maxima and minima each occurring at approximately 24-hour intervals. Each hollow of low temperature, represented by its minimum, is of course separated by crests of higher temperature from adjacent hollows; and, similarly, each daily crest of high temperature is separated from adjacent crests by hollows of low temperature. The effects of each crest and hollow of the daily march of temperature upon the daily periodic activities of vegetable and animal life, as well as upon human comfort and activities, are consequently separated from the effects of adjoining crests and hollows, respectively, by effects of intervening periods of temperature of the opposite sense. Therefore, from a biological standpoint, each daily recorded maximum temperature should be the highest between immediately preceding and following minima; and each daily minimum should be the lowest between the immediately preceding and following maxima.

If all stations had thermographs, such desired data could readily be obtained; but the majority of stations are not so equipped, temperature data being generally obtained from maximum and minimum thermometers only. If we read and set the maximum thermometer at about the usual time of the early morning minimum, say, at 7 or 8 a. m., local time, we obtain the maximum of the preceding 24 hours' wave crest and we set the thermometer at a proper time to obtain the maximum of the next succeeding crest. Similarly, if we read and set the minimum thermometer at about the usual time of the daily maximum temperature, say at about 3 p. m., we obtain the minimum of the preceding hollow of low temperature and we set our minimum thermometer at a proper time to obtain the minimum of the next succeeding hollow. It would have been better, therefore, if we had taken 3 p. m. instead of 6 p. m. as our standard time in our study of minimum temperature data, above. However, we have found differences between the 3 and the 6 p. m. data at Rio Grande Valley stations to be relatively infrequent and of no great importance. Under ordinary conditions some latitude exists in choosing a time that is fairly suitable; and it is for this reason that we can select

[3] "A Classification of Weather Types", by E. S. Nichols, MONTHLY WEATHER REVIEW, October 1925, 431-434. Also "Das Klima als Wettergesammtheit", translated and summarized by E. S. Nichols, MONTHLY WEATHER REVIEW, September 1927, 55, 401-403.

a time that is fairly satisfactory for reading and setting both thermometers.

The ideal situation can almost be obtained with little difficulty at special stations with paid observers who take and transmit temperature observations daily in the early morning, if we adopt the following arrangements, which have heretofore been made in the lower Rio Grande Valley Frost Service and, it is understood, to some extent elsewhere: Both thermometers are to be read and set at the early-morning observation; in addition the minimum thermometer, only, is to be read and set in the late afternoon or early evening (say, at about sunset). The morning readings (maximum during the preceding 24 hours, minimum during the night just ended) are telegraphed or otherwise transmitted; while the maximum then read is entered under the current date on the monthly-report form, but is set back to the preceding date (on which it almost always occurs) in published reports. The minimum to be recorded for any date is the lower of the two minima read on that date, this being the lowest temperature of the 24 hours ending at the sunset observation. The additional late-afternoon reading and setting of the minimum thermometer can doubtless be required of paid special observers generally; while in cases where compensation allowed for observers' services is insufficient, the great improvement in minimum-temperature records that would result (as compared with once-daily early-morning observations) appears to warrant a small additional allowance for services. It seems, also, that as many as practicable of the other non-thermograph stations should make temperature observations and records according to the same system, which may be looked on as a goal to be reached if practicable.

ONCE DAILY OBSERVATIONS

At a majority of stations, however, it appears that for the present for practical reasons both thermometers must be read and set at the same time, since most observers are cooperative and unpaid. Our study of data herewith has shown that the early morning is a very unsuitable time for a single daily observation, because of effects on the minimum-temperature record. Neither can 3 p.m. nor other time near that of the daily maximum be chosen, because maxima thus obtained would often be too high as compared with the true maximum from minimum to minimum. An intermediate time must be selected, which should be, if consistent with reasonable accuracy, convenient for the cooperative observers generally. Although late forenoon would produce fairly accurate results, such time would be generally inconvenient. Any generally convenient and accurate time must be later than the ususal time of the daily maximum.

If we consider midnight: An examination of the Harlingen thermograph traces for the 12 months used in our minimum-temperature study shows that true maxima are obtained in all but 5 or 6 percent of all dates; in most of the exceptional cases temperature had not, by midnight, fallen as low as the maxima of the immediately following day, while in some other cases no true maximum crest appears on the thermograms. Thus, very satisfactory maximum data would be obtained by midnight observations. However, we have found that in the data we have studied the midnight-to-midnight minima differ in about one-fourth of all cases from the standard. This is not satisfactory. Also, midnight is an impossible time for making cooperative-station observations; so also is, in general, any time much later than about sunset or 6 p. m.

By 6 p. m. (in data studied) temperature had usually fallen lower than the maximum of the next-following day; but a further examination of the Harlingen thermograms previously used shows that in about 12 percent of the cases the maximum for the 6 p. m.-ending day was too high. These differences are to be regretted; but we have found that 6 p. m. gives very satisfactory minimum temperatures; and it is also usually convenient, and is, on the whole, the most satisfactory.

CONCLUSION

We may, therefore, conclude:

(1) That at thermograph stations and at other stations where twice-daily observations can be taken, daily maximum temperatures should be obtained for the 24 hours ending at about the usual time of the early morning minima while daily minima should be taken for 24-hour periods ending in the afternoon, say, about sunset or 6 p. m.

(2) That at nonthermograph stations at which twice-daily observations cannot be taken, the once-daily observations should be taken in the late afternoon or early evening, say, at about sunset or 6 p. m., as now at most cooperative stations.

(3) That once-daily early morning observations produce minimum-temperature records so misleading that such observations should be discontinued as far as practicable.

In this manner minimum temperatures would be obtained for the same periods at all stations, and would thus be truly comparable (as well as correct), while the daily maxima obtained usually would be comparable.

The effects of variations in time of observations upon daily and monthly mean temperatures is not considered herein. This matter has been previously investigated.[2]

[2] See footnote 2 on p. 338.

TABLE 1.—*Effects of variations in the period taken as the day upon the record of minimum temperature at Harlingen, Tex. (during 12 selected months)*

Periods	Departures from 6 p. m. to 6 p. m. minimum temperatures, numbers of differing cases and amounts of differences																						Number of days with minimum temperatures of—											
	7 a. m. to 7 a. m. minima										8 a. m. to 8 a. m. minima										Midnight to midnight minima										40° or below (days ending)				32° or below (days ending)				25° or below (days ending)			
	Positive departures			Negative departures			Total differences		Resultant		Positive departures			Negative departures			Total differences		Resultant		Positive departures			Negative departures			Total differences		Resultant		7 a. m.	8 a. m.	Midnight	6 p. m.	7 a. m.	8 a. m.	Midnight	6 p. m.	7 a. m.	8 a. m.	Midnight	6 p. m.
	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily average	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily average	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily average														
December 1931	+10	2	+5	−59	12	−18	69	4.9	−49	−1.6	+11	2	+6	−45	11	−16	56	4.3	−34	−1.1	+11	5	+5	−38	6	−12	49	4.5	−27	−0.9	1	1	1	1	0	0	0	0	0	0	0	0
1932	+18	3	+10	−62	13	−13	80	5.0	−44	−1.4	+26	3	+11	−44	8	−11	64	5.8	−24	−0.8	+12	4	+4	−29	7	−7	41	3.7	−17	−0.5	7	7	7	7	2	2	1	1	0	0	0	0
1933	+11	1	+11	−64	17	−9	75	4.2	−53	−1.7	+9	1	+9	−19	7	−6	28	3.5	−10	−0.3	+1	1	+1	−21	6	−7	22	3.1	−20	−0.6	2	1	1	1	0	0	0	0	0	0	0	0
3 Decembers	+39	6	+11	−185	42	−18	224	4.7	−146	−1.6	+40	6	+11	−148	26	−16	−148	4.6	−68	−0.7	+24	10	+5	−88	19	−12	112	3.9	−64	−0.7	10	9	9	9	2	2	1	1	0	0	0	0
January 1932	+30	6	+11	−103	11	−24	133	7.8	−73	−2.4	+30	5	+12	−79	10	−21	109	7.3	−49	−1.6	+8	4	+3	−35	8	−8	43	3.6	−27	−0.9	4	3	4	3	0	0	0	0	0	0	0	0
1933	+8	2	+4	−91	13	−15	99	6.6	−83	−2.7	+5	2	+3	−57	11	−13	62	4.8	−52	−1.7	0	0	0	−20	7	−6	20	2.9	−20	−0.6	2	2	1	1	0	0	0	0	0	0	0	0
1934	+18	5	+7	−56	11	−12	74	4.6	−38	−1.2	+14	3	+7	−44	10	−10	58	4.5	−30	−1.0	+4	2	+3	−24	9	−10	28	2.5	−20	−0.6	0	0	0	0	0	0	0	0	0	0	0	0
3 Januarys	+56	13	+11	−250	35	−24	306	6.4	−194	−2.1	+49	10	+12	−180	31	−21	229	5.6	−131	−1.4	+12	6	+3	−79	24	−10	91	3.0	−67	−0.7	6	5	5	4	0	0	0	0	0	0	0	0
February 1932	+4	1	+4	−55	14	−13	59	3.9	−51	−1.7	+4	1	+4	−39	9	−10	43	4.3	−35	−1.2	0	0	0	−13	5	−6	13	2.6	−13	−0.4	0	0	0	0	0	0	0	0	0	0	0	0
1933	+22	6	+6	−63	9	−20	85	5.7	−41	−1.5	+17	5	+6	−44	9	−15	61	4.4	−27	−1.0	+1	1	+1	−34	6	−20	35	5.0	−33	−1.2	5	5	4	3	3	2	2	2	0	0	0	0
1934	+12	1	+12	−50	14	−7	62	4.1	−38	−1.4	+13	2	+12	−11	5	−4	24	3.4	+2	+0.1	+1	1	+1	−25	2	−13	26	8.7	−24	−0.8	0	0	0	0	0	0	0	0	0	0	0	0
3 Februarys	+38	8	+12	−168	37	−20	206	4.6	−130	−1.5	+34	8	+12	−91	23	−15	128	4.1	−60	−0.7	+2	2	+1	−72	13	−20	74	4.9	−70	−0.8	5	5	4	3	3	2	2	2	0	0	0	0
March 1932	+13	2	+11	−93	13	−18	106	7.1	−80	−2.6	+9	2	+8	−49	8	−13	58	5.8	−40	−1.3	+2	1	+2	−36	9	−7	38	3.8	−34	−1.1	9	8	8	7	4	3	3	2	0	0	0	0
1933	+4	2	+3	−70	10	−16	74	6.2	−66	−2.1	+4	1	+4	−44	8	−18	48	5.3	−40	−1.3	+2	1	+2	−30	6	−10	32	4.6	−28	−0.9	0	0	0	0	0	0	0	0	0	0	0	0
1934	+22	2	+19	−52	14	−10	74	4.6	−30	−1.0	+20	2	+19	−12	5	−5	32	4.6	+8	+0.3	+1	1	+1	−15	2	−11	16	5.3	−14	−0.5	2	2	2	2	0	0	0	0	0	0	0	0
3 Marches	+39	6	+19	−215	37	−18	254	5.9	−176	−1.9	+33	5	+19	−105	21	−18	138	5.3	−72	−0.8	+5	3	+2	−81	17	−11	86	4.3	−76	−0.8	11	10	10	9	4	3	3	2	0	0	0	0
Frequencies of differing cases:																																										
Total numbers		33			151				184			29			101				130			21			73					94				7	4	3		4	2	1		0	0	0	0
Percentages									51										36											26				28	16	12		80	40	20		0	0	0	0

TABLE 2.—*Effects of variations in the period taken as the day upon the record of minimum temperature at Mission, Tex. (during 12 selected months)*

Periods	Departures from 6 p. m. to 6 p. m. minimum temperatures, numbers of differing cases and amounts of differences																						Number of days with minimum temperatures of—											
	7 a. m. to 7 a. m. minima										8 a. m. to 8 a. m. minima										Midnight to midnight minima										40° or below (days ending)				32° or below (days ending)				25° or below (days ending)			
	Positive departures			Negative departures			Total differences		Resultant		Positive departures			Negative departures			Total differences		Resultant		Positive departures			Negative departures			Total differences		Resultant		7 a. m.	8 a. m.	Midnight	6 p. m.	7 a. m.	8 a. m.	Midnight	6 p. m.	7 a. m.	8 a. m.	Midnight	6 p. m.
	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages														
December 1931	+9	2	+5	−68	8	−19	77	7.7	−59	−1.9	+9	2	+5	−47	6	−16	56	7.0	−38	−1.2	0	0	0	−44	9	−16	44	4.9	−44	−1.4	2	2	1	1	0	0	0	0	0	0	0	0
1932	+14	2	+8	−75	13	−17	89	5.9	−61	−2.0	+13	2	+7	−57	10	−14	70	5.8	−44	−1.4	+1	1	+1	−34	8	−7	35	3.9	−33	−1.1	8	8	8	8	2	2	3	2	0	0	0	0
1933	0	0	0	−81	18	−10	81	4.5	−81	−2.6	0	0	0	−44	12	−9	44	3.7	−44	−1.4	+1	1	+1	−20	5	−9	21	4.2	−19	−0.6	4	2	2	2	0	0	0	0	0	0	0	0
3 Decembers	+23	4	+8	−224	39	−19	247	5.7	−201	−2.2	+22	4	+7	−148	28	−16	170	5.3	−126	−1.4	+2	2	+1	−98	22	−16	100	4.2	−96	−1.0	14	12	11	11	2	2	3	2	0	0	0	0
January 1932	+21	5	+9	−91	12	−23	112	6.6	−70	−2.3	+21	4	+9	−69	10	−18	90	6.4	−48	−1.5	+5	2	+3	−66	9	−18	71	6.5	−61	−2.0	5	3	3	3	0	0	0	0	...	...	...	...
1933	0	0	0	−96	12	−16	96	8.0	−96	−3.1	0	0	0	−61	11	−13	61	5.5	−61	−2.0	0	0	0	−16	4	−9	16	4.0	−16	−0.5	3	3	2	2	2	1	1	1	...	...	...	...
1934	+8	2	+4	−45	8	−14	53	5.3	−37	−1.2	+9	3	+4	−35	8	−10	44	4.0	−26	−0.8	+2	1	+2	−27	8	−14	29	3.2	−25	−0.8	0	0	0	0	0	0	0	0	...	...	...	...
3 Januarys	+29	7	+9	−232	32	−23	261	6.7	−203	−2.2	+30	7	+9	−165	29	−18	195	5.4	−135	−1.5	+7	3	+3	−109	21	−18	116	4.8	−102	−1.1	8	6	5	5	2	1	1	1	0	0	0	0
February 1932	0	0	0	−61	14	−14	61	4.4	−61	−2.1	0	0	0	−33	7	−12	33	4.7	−33	−1.1	0	0	0	−8	3	−5	8	2.7	−8	−0.3	0	0	0	0	0	0	0	0	...	...	...	...
1933	+10	5	+4	−63	8	−23	73	5.6	−53	−1.9	+9	5	+3	−53	8	−21	62	4.8	−44	−1.6	+3	2	+2	−26	4	−18	29	4.8	−23	−0.8	6	5	6	5	3	3	2	2	...	...	...	...
1934	+11	1	+11	−54	13	−10	65	4.6	−43	−1.5	+11	1	+11	−44	15	−8	55	3.4	−33	−1.2	0	0	0	−27	3	−13	27	9.0	−27	−1.0	2	1	1	1	0	0	0	0	...	...	...	...
3 Februarys	+21	6	+11	−178	35	−23	199	4.9	−157	−1.8	+20	6	+11	−130	30	−21	150	4.2	−110	−1.3	+3	2	+2	−61	10	−18	64	5.3	−58	−0.7	8	6	7	6	3	3	2	2	0	0	0	0
March 1932	+8	1	+8	−100	13	−17	108	7.7	−92	−3.0	0	0	0	−29	7	−8	29	4.1	−29	−0.9	0	0	0	−24	6	−9	24	4.0	−24	−0.8	9	7	7	7	3	2	2	2	...	...	...	...
1933	0	0	0	−72	11	−15	72	6.5	−72	−2.3	0	0	0	−30	7	−10	30	4.3	−30	−1.0	0	0	0	−20	6	−6	20	3.3	−20	−0.6	0	0	0	0	0	0	0	0	...	...	...	...
1934	+20	1	+20	−67	17	−10	87	4.8	−47	−1.5	+20	1	+20	−16	5	−5	36	6.0	+4	+0.1	+1	1	+1	−17	2	−13	17	6.0	−16	−0.5	5	4	4	4	0	0	0	0	...	...	...	...
3 Marches	+28	2	+20	−239	41	−17	267	6.2	−211	−2.3	+20	1	+20	−75	19	−10	95	4.8	−55	−0.6	+1	1	+1	−61	14	−13	61	4.1	−60	−0.6	14	11	11	11	3	2	2	2	0	0	0	0
Differing cases:																																										
Total numbers					166												124												75				11	2	1		3	1	1		0	0	0	0
Percentage frequencies					46												34												21				33	6	3		43	14	14		0	0	0	0

TABLE 3.—*Effects of variations in the period taken as the day upon the record of minimum temperature at Dilley, Tex. (during 12 selected months)*

Periods	Departures from 6 p. m. to 6 p. m. minimum temperatures, numbers of differing cases and amounts of differences																								Number of days with minimum temperature of—											
	7 a. m. to 7 a. m. minima									8 a. m. to 8 a. m. minima									Midnight to midnight minima									40° or below (days ending)				32° or below (days ending)				25° or below (days ending)			
	Positive departures			Negative departures			Total differences		Resultant departure		Positive departures			Negative departures			Total differences		Resultant departure		Positive departures			Negative departures			Total differences		Resultant departure											
	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages	7 a. m.	8 a. m.	Midnight	6 p. m.	7 a. m.	8 a. m.	Midnight	6 p. m.	7 a. m.	8 a. m.	Midnight	6 p. m.
December 1931	+7	1	+7	−60	11	−14	67	5.6	−53	−1.7	+9	1	+9	−28	6	−8	37	5.3	−19	−0.6	0	0	0	−32	7	−12	32	4.6	−32	−1.0	13	11	12	10	1	1	1	1	0	0	0	0
1932	+3	2	+2	−63	10	−11	66	5.5	−60	−1.9	+5	2	+3	−45	10	−15	50	4.2	−40	−1.3	+3	1	+3	−24	5	−8	27	4.5	−21	−0.7	17	15	12	12	4	4	4	3	2	1	1	1
1933	+3	1	+3	−69	14	−10	72	4.8	−66	−2.1	+4	1	+4	−44	11	−10	48	4.0	−40	−1.3	+2	1	+2	−39	5	−13	41	6.8	−37	−1.2	8	7	7	6	0	0	0	0	0	0	0	0
3 Decembers	+13	4	+7	−192	35	−14	205	5.3	−179	−1.9	+18	4	+9	−117	27	−15	135	4.4	−99	−1.1	+5	2	+3	−95	17	−13	100	5.3	−90	−1.0	38	33	31	28	5	5	5	4	2	1	1	1
January 1932	+2	1	+2	−77	9	−20	79	7.9	−75	−2.4	+2	1	+1	−65	9	−18	67	6.7	−63	−2.0	+9	2	+5	−43	7	−12	52	5.8	−34	−1.1	15	15	14	13	2	1	1	1	0	0	0	0
1933	+7	2	+4	−99	12	−12	106	7.6	−92	−3.0	+5	2	+3	−84	10	−14	89	7.4	−79	−2.5	+6	2	+5	−12	4	−6	18	3.0	−6	−0.2	7	6	5	5	3	2	2	2	2	1	1	1
1934	+12	6	+3	−84	12	−16	96	5.3	−72	−2.3	+5	2	+3	−74	12	−14	79	5.6	−69	−2.2	0	0	0	−24	6	−12	24	4.0	−24	−0.8	12	12	10	10	4	3	3	3	0	0	0	0
3 Januarys	+21	9	+4	−260	33	−20	281	6.7	−239	−2.6	+12	5	+3	−223	31	−18	235	6.5	−211	−2.3	+15	4	+5	−79	17	−12	94	4.5	−64	−0.7	34	33	29	28	9	6	6	6	2	1	1	1
February 1932	+10	1	+10	−62	14	−12	72	4.7	−52	−1.8	+11	1	+11	−35	8	−11	46	5.1	−24	−0.8	+7	1	+7	−20	4	−8	27	5.4	−13	−0.4	2	2	1	1	0	0	0	0	0	0	0	0
1933	+9	4	+5	−79	11	−25	88	5.9	−70	−2.5	+9	3	+5	−68	11	−22	77	5.5	−59	−2.1	0	0	0	−25	6	−17	25	4.2	−25	−0.9	8	7	7	6	6	5	6	4	3	3	2	2
1934	0	0	0	−68	14	−17	68	4.9	−68	−2.4	0	0	0	−61	12	−16	61	5.1	−61	−2.2	+2	1	+2	−24	2	−13	26	8.7	−22	−0.8	9	9	7	7	2	2	1	1	0	0	0	0
3 Februarys	+19	5	+10	−209	39	−25	228	5.2	−190	−2.2	+20	4	+11	−164	31	−22	184	5.3	−144	−1.7	+9	2	+7	−69	12	−17	78	5.6	−60	−0.7	19	18	15	14	8	7	7	5	3	3	2	2
March 1932	+6	1	+6	−87	10	−18	93	8.5	−81	−2.6	+6	1	+6	−41	9	−14	47	4.7	−35	−1.1	0	0	0	−32	6	−9	32	5.3	−32	−1.0	11	10	10	10	7	6	6	6	0	0	0	0
1933	+4	1	+4	−77	16	−10	81	4.8	−73	−2.4	+5	1	+5	−52	11	−8	57	4.8	−47	−1.5	0	0	0	−9	3	−4	9	3.0	−9	−0.3	2	1	1	1	0	0	0	0	0	0	0	0
1934	+17	2	+16	−82	15	−12	99	5.8	−65	−2.1	+19	2	+18	−23	8	−8	42	4.2	−4	−0.1	+2	1	+2	−4	1	−4	6	3.0	−2	−0.1	11	8	7	7	2	1	1	1	0	0	0	0
3 Marches	+27	4	+16	−246	41	−18	273	6.1	−219	−2.4	+30	4	+18	−116	28	−14	146	4.6	−86	−0.9	+2	1	+2	−45	10	−9	47	4.3	−43	−0.5	24	19	18	18	9	7	7	7	0	0	0	0
Differing cases:																																										
Total number					170										134									65							27	15	5		9	3	3		3	1	0	
Percentage frequency					47										37									18							31	17	6		41	14	14		75	25	0	

TABLE 4.—*Effects of variations in the period taken as the day upon the record of minimum temperature at Harlingen, Tex. (during 12 selected months)*

Periods	9 a. m. to 9 a. m. minima										10 a. m. to 10 a. m. minima									
	Positive departures			Negative departures			Total differences		Resultant departures		Positive departures			Negative departures			Total differences		Resultant departures	
	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages
December 1931	+12	2	+7	−16	3	−10	28	5.6	−4	−0.1	+12	2	+7	0	0	0	12	6.0	+12	+0.4
1932	+21	4	+8	−17	4	−7	38	5.4	+4	+0.1	+23	4	+8	−9	3	−4	32	4.6	+14	+0.5
1933	+7	1	+7	−6	1	−6	13	6.5	+1	0	+6	1	+6	−5	1	−5	11	5.5	+1	0
3 Decembers	+40	7	+8	−39	8	−10	79	5.3	+1	0	+41	7	+8	−14	4	−5	55	5.0	+27	+0.3
January 1932	+29	4	+13	−45	7	−14	74	6.7	−16	−0.5	+28	3	+13	−7	3	−5	35	5.8	+21	+0.7
1933	+3	1	+3	−19	3	−8	22	5.5	−16	−0.5	+3	1	+3	−3	1	−3	6	3.0	0	0
1934	+16	4	+7	−15	3	−6	31	4.4	+1	0	+18	4	+7	0	0	0	18	4.5	+18	+0.6
3 Januarys	+48	9	+13	−79	13	−14	127	5.8	−31	−0.3	+49	8	+13	−10	4	−5	59	4.9	+39	+0.4
February 1932	+1	1	+1	−15	5	−7	16	2.7	−14	−0.5	0	0	0	−3	1	−3	3	3.0	−3	−0.1
1933	+11	4	+5	−22	5	−10	33	3.7	−11	−0.4	+9	3	+4	−6	1	−6	15	3.8	+3	+0.1
1934	+15	2	+14	−2	1	−2	17	5.7	+13	+0.5	+15	2	+14	0	0	0	15	7.5	+15	+0.5
3 Februarys	+27	7	+14	−39	11	−10	66	3.7	−12	−0.2	+24	5	+14	−9	2	−6	33	4.7	+15	+0.2
March 1932	+8	1	+8	−15	4	−6	23	4.6	−7	−0.2	+8	1	+8	−2	1	−2	10	5.0	+6	+0.2
1933	+2	1	+2	−2	1	−2	4	2.0	0	0	+2	1	+2	0	0	0	2	2.0	+2	+0.1
1934	+19	1	+19	−6	2	−4	25	8.3	+13	+0.4	+8	1	+8	−3	1	−3	11	5.5	+5	+0.2
3 Marches	+29	3	+19	−23	7	−6	52	5.2	+6	+0.1	+18	3	+8	−5	2	−3	23	4.6	+13	+0.1
Differing cases:																				
Total numbers		26			39				65			23			12				35	
Percentage frequencies									18										10	

Periods	Noon to noon minima								3 p. m. to 3 p. m. minima								Number of days with minima of—							
	Positive differences			Negative departures			Total differences		Resultant departures		Positive departures			Negtive departures			Total differences		Resultant departures		40° or below (days ending)				32° or below (days ending)			
	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages	Sums	Numbers	Greatest	Sums	Numbers	Greatest	Sums	Averages	Sums	Daily averages	9 a. m.	10 a. m.	Noon	3 p. m.	9 a. m.	10 a. m.	Noon	3 p. m.
December 1931	+12	2	+7	0	0	0	12	6.0	+12	+0.4	+9	2	+7	0	0	0	9	4.5	+9	+0.3	1	1	1	1	0	0	0	0
1932	+18	3	+7	−2	1	−2	20	5.0	+16	+0.5	+13	3	+7	−1	1	−1	14	3.5	+12	+0.4	7	7	7	7	2	1	1	1
1933	+2	1	+2	−1	1	−1	3	1.5	+1	0	+1	1	+1	0	0	0	1	1.0	+1	0	1	1	1	1	0	0	0	0
3 Decembers	+32	6	+7	−3	2	−2	35	4.4	+29	+0.3	+23	6	+7	−1	1	−1	24	3.4	+22	+0.2	9	9	9	9	2	1	1	1
January 1932	+7	2	+4	−1	1	−1	8	2.7	+6	+0.2	+5	2	+3	0	0	0	5	2.5	+5	+0.2	3	3	3	3	0	0	0	0
1933	+3	1	+3	0	0	0	3	3.0	+3	+0.1	+4	1	4	0	0	0	4	4.0	+4	+0.1	1	1	1	1	0	0	0	0
1934	+18	4	+7	0	0	0	18	4.5	+18	+0.6	+12	4	+5	0	0	0	12	3.0	+12	+0.4	0	0	0	0	0	0	0	0
3 Januarys	+28	7	+7	−1	1	−1	29	3.6	+27	+0.3	+21	7	+5	0	0	0	21	3.0	+21	+0.2	4	4	4	4	0	0	0	0
February 1932	0	0	0	−1	1	−1	1	1.0	−1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1933	+7	2	+4	0	0	0	7	3.5	+7	+0.2	+5	2	+4	0	0	0	5	2.5	+5	+0.2	4	4	3	3	2	2	2	2
1934	+13	2	+12	0	0	0	13	6.5	+13	+0.5	+1	1	+1	0	0	0	1	1.0	+1	0	0	0	0	0	0	0	0	0
3 Februarys	+20	4	+12	−1	1	−1	21	4.0	+19	+0.2	+6	3	+4	0	0	0	6	2.0	+6	+0.1	4	4	3	3	2	2	2	2
March 1932	+8	1	+8	0	0	0	8	8.0	+8	+0.3	+4	1	+4	0	0	0	4	4.0	+4	+0.1	7	7	7	7	2	2	2	2
1933	+2	1	+2	0	0	0	2	2.0	+2	+0.1	+2	1	+2	0	0	0	2	2.0	+2	+0.1	0	0	0	0	0	0	0	0
1934	+2	1	+2	−2	1	−2	4	2.0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	0	0	0
3 Marches	+12	3	+8	−2	1	−2	14	3.5	+10	+0.1	+6	2	+4	0	0	0	6	3.0	+6	+0.1	9	9	9	9	2	2	2	2
Differing cases:																												
Total numbers		20			5				25			18			1					19	1	1	0	0	1	0	0	0
Percentage frequencies									7											5	4	4	0	0	20	0	0	0